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## The Utilization of Metabolic Training Zones in Pubertal Swimmers

Gheorghe Marinescu<sup>a</sup>, Adrian Radulescu<sup>ab</sup>, Laurentiu Ticala<sup>a\*</sup>

\* Corresponding author: Laurentiu Ticala, ticala\_laurentiu@yahoo.com

<sup>a</sup>National University of Physical Education and Sports, 140 Constantin Noica Street, Bucharest, Romania

<sup>b</sup>Aqua Team Swimming Club, 6-8 Chisinau Blvd., Bucharest, Romania

### Abstract

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Starting to train swimmers at an early age, as well as continuous training during the growth stages should target the achievement of the best results at both junior and senior levels. Considering the functional and somatic characteristics of pubertal swimmers, the training plan involved the use of workouts structured on metabolic training zones similar to those used at the senior level swimmers. The experiment aimed to highlight the effects of training methods based on the model for senior swimmers on the aerobic capacity of pubertal swimmers. Through advanced methods of monitoring the effort made by pubertal swimmers during training, we collected data which were then processed using statistical and mathematical methods. The analysis of the results from T-2000 Test before and after the observation period showed an average improvement of 40 seconds, indicating that the training plan based on training zones similar to the senior level swimmers produced a development in the aerobic capacity of the pubertal swimmers.

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**Keywords:** Training zones; effort monitoring; pubertal swimmers; aerobic capacity; T-2000 Test.

### 1. Introduction

Successful sports performance implies serious and well-coordinated training, which should use the biological possibilities of the athlete as efficiently as possible. For this reason, the coach is compelled to adapt the effort parameters depending on the functional and somatic characteristics of the swimmers' age indicators, in order to obtain the best results and not to cause health problems.

"Aerobic training or cardiorespiratory endurance training improves central and peripheral blood flow and enhances the capacity of the muscle fibers to generate greater amounts of adenosine triphosphate" (Wilmore, Costill, & Kenney, 2008: 222).

Aerobic training is largely considered to be the most important aspect of physical fitness, and “all athletes can benefit from maximizing their endurance” (Wilmore, Costill, & Kenney, 2008: 245).

According to Olbrecht (2000), “the better the aerobic system is developed, the more oxygen can be used and the faster one can swim during prolonged exercises. Aerobic capacity is therefore the major factor determining performance in long distance event”.

Aerobic effort capacity refers to the body’s possibilities to carry out sub-maximal moderate effort, and to maintain it as long as possible through aerobic metabolism (oxidative phosphorylation) of the carbohydrate and lipid sub-layer.

Access to new information about specific swimming effort has led to the division of effort into areas with maximum influence on several biological factors. Marinescu (2003: 65) argues that the “translation from the notion of distance to the notion of time has resulted in zones of effort in preparing swimmers, and this zoning is based on energy sources specific to the try-out”.

We developed a 3-month training plan, during which we used both classical and metabolic aquatic training methods. This allowed us to schedule the effort in different areas and monitor it afterwards with the help of telemetric equipment and by measuring blood lactate concentration.

In order to determine the efficiency of using effort zones, the subjects were tested at the beginning and the end of the observation period, with the intent to calculate the degree of improvement in their aerobic capacity.

The main objective of this research paper is to obtain conclusive data on the influence and efficiency of training effort zoning on the aerobic capacity of a group of pubertal swimmers, in order to achieve improved performance in competitions.

### *1.1. Hypothesis*

The physical effort carried out by pubertal swimmers, aged 12-16, during aquatic training can be divided into effort zones, depending on their heart rate and blood lactate concentration, following the model used in preparing seniors to improve their aerobic capacity.

## **2. Materials and methods**

In developing this paper, we used the experimental method, controlled observation, testing method (T-2000 Test), graphical method, and statistical and mathematical method with the following indices: mean, standard deviation and variance.

### *2.1. Duration, location and subjects*

The research took place at Aqua Team Sports Club of Bucharest. The study lasted 84 days, starting on 15 September 2014 and ending on 7 December 2014. The subjects were 5 pubertal swimmers, aged between 12 and 16 years. The participants were at that time components of Aqua Team Sports Club, Bucharest. The club has 5 teams with a total of 120 athletes, aged between 5 and 16 years. They were the first generation of club juniors and they all hold national championship titles in various try-outs.

## 2.2. The test

The T-2000 Test (Maglischo, 2003) was used to test changes in aerobic capacity of the swimmer. This involves that the swimmer should swim as fast as possible a distance of 2000 metres, and the lap times in every 100 metres to be equal between them.

The times for every 100 metres should correspond to the anaerobic threshold, the swimmer being compelled to maintain this speed throughout the test. In the eventuality that there is a difference bigger than 4 seconds between the fastest and the slowest 100 metres, the result of the test is disregarded. The final time after 2000 metres is recorded.

## 2.3. The device/equipment used

The G.T. Aqua Hosand telemetry system is unique in the world and offers the possibility of monitoring heart rate values of up to 32 swimmers in real time. All data were collected with a Heart Rate Monitor (HRM) placed on the swimmer's chest and transmitted by a transmitter to the central unit (PC, laptop).

The data received is processed by special software: MCSOft. In addition to recording the heart rate in real time, this software enables the division of data into effort zones and the acquisition of statistical reports regarding the effort monitored.

Coupled with the use of the heart rate monitoring system, we used a device for measuring blood lactate concentration. Lactate Meter Plus is a Nova Biomedical product which is characterized by a high-speed of analysis (13 seconds) and a maximum deviation of 0.2mM.

The telemetry system software has a function of zoning effort through five different colours. These can be set up manually by the user, taking into account the biological peculiarities of the group of athletes:

- Green – aerobic threshold
- Light Yellow – slow anaerobic threshold
- Dark Yellow – anaerobic threshold
- Pink – maximal oxygen consumption
- Red – anaerobic endurance

## 3. Results

**Table 1.** Swimming volume during the training plan/ observation period

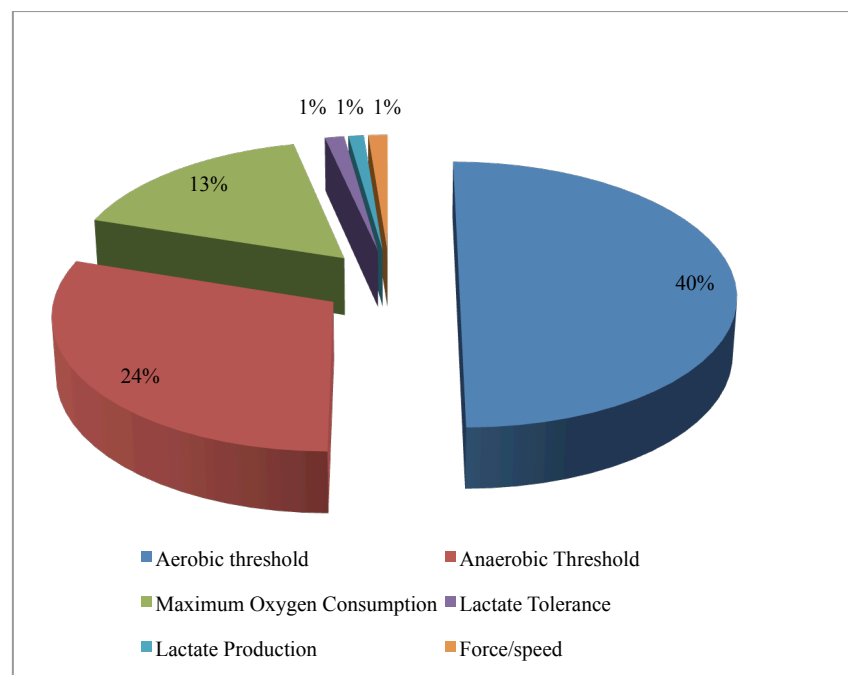
Week	Weekly volume (meters)	Number of training sessions
15 – 21 Sept	60,000	9
22 – 28 Sept	68,000	9
29 – 5 Oct	77,000	10
6 – 12 Oct	85,000	11
13 – 19 Oct	77,000	12
20 – 26 Oct	90,000	12

27 – 2 Oct	90,000	12
3 – 9 Nov	77,000	12
9 – 16 Nov	100,000	12
17 - 23 Nov	75,000	12
24 - 30 Nov	100,000	12
1 – 7 Dec	75,000	10
Total volume	974,000	133

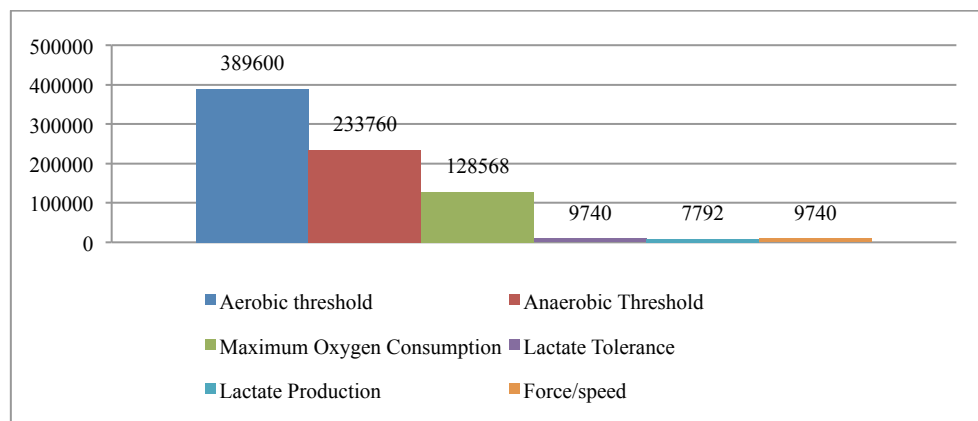
In Table 1, we can see that during 13 weeks the participants swam a total of 974,000 metres. Also, in Table 2, Figure 1 and Figure 2, we highlighted the volume swum in each zone of effort.

**Table 2.** The division of volumes swum in each effort zone (%/meters)

Aerobic Threshold	Anaerobic Threshold	Maximal Oxygen Consumption	Lactate Tolerance	Lactate Production	Force// Speed
40%	24%	13%	1%	1%	1%
389,600m	233,760m	128,568m	9,740m	7,792m	9,740m



**Fig. 1.** The division of volumes swum in each effort zone (%)

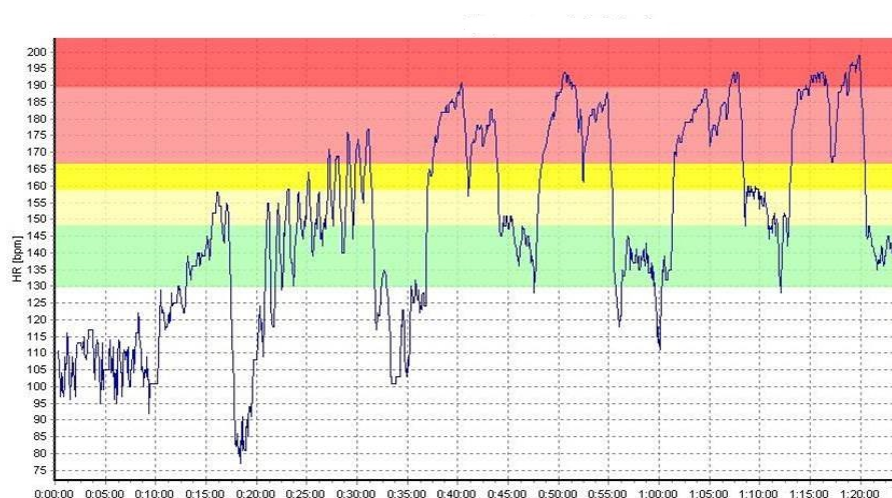


**Fig. 2.** The division of volumes swum in each effort zone (meters)

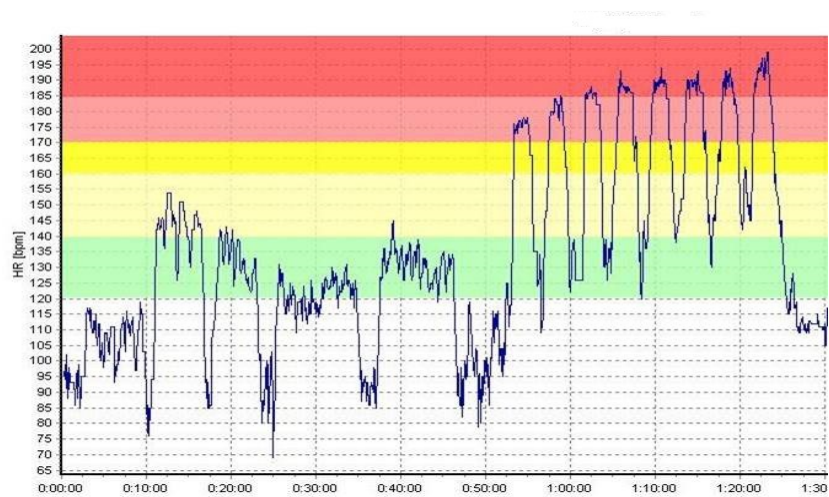
In Table 3 and Figures 3, 4, 5 and 6, we can observe the data acquired with the effort monitoring equipment throughout the training session. These represent the physiological responses of the pubertal swimmers' bodies to training sets which aim at different effort zones. The sets were standardized in order to bring continuity in training and the possibility to observe the swimmers' adaptation to their requirements.

**Table 3.** The physiological responses to standardized training sets

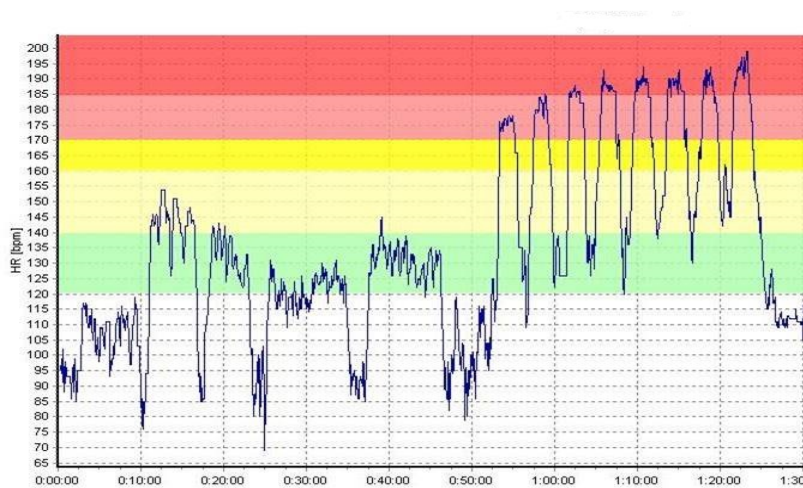
Standardized training sets	Name	Age	Gender	Average Heart Rate	Blood Lactate Concentration
4x(300m + 2x100m + 200m) freestyle	S.B.	15	M	175 bpm	12.7 mM
4x(300m + 2x100m + 200m) freestyle	V.T.	15	M	163 bpm	13.4 mM
8x200 m freestyle	V.S.	16	M	187 bpm	10.5 mM
8x200 m freestyle	C.I.	16	F	182 bpm	11.2 mM
40x124 m freestyle	C.G.	12	F	159 bpm	4.5 mM



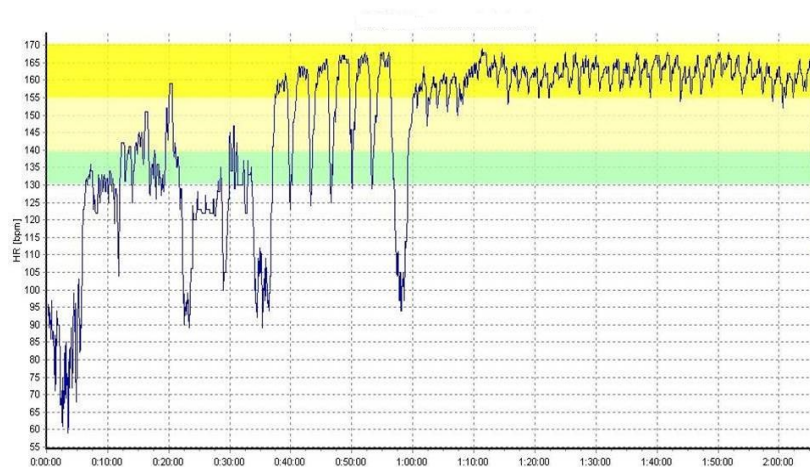
**Fig. 3.** The physiological response to standardized training set – S.B. – 25.09.2014 – Blood Lactate Concentration: 12.7mM



**Fig. 4.** The physiological response to standardized training set – V.S. – 23.10.2014 – Blood Lactate Concentration: 10.5mM



**Fig. 5.** The physiological response to standardized training set – C.I. – 23.10.2014 – Blood Lactate Concentration: 11.2mM

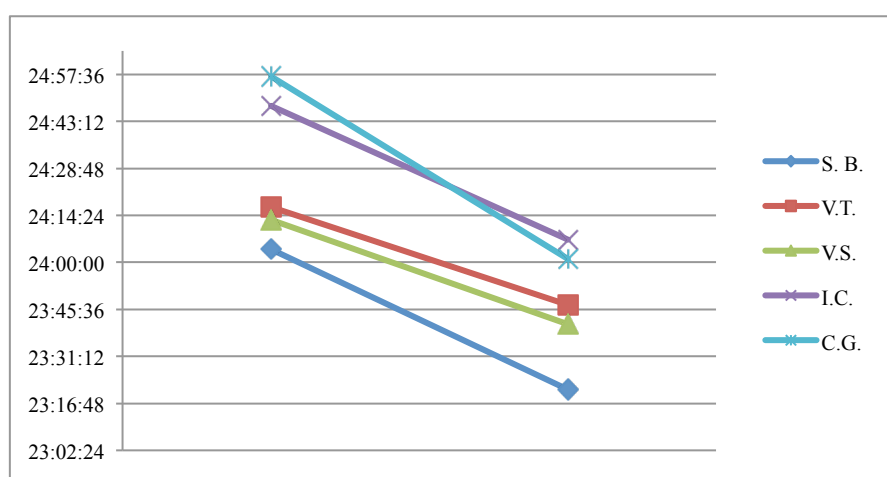


**Fig. 6.** The physiological response to standardized training set – C.G. – 4.11.2014 – Blood Lactate Concentration: 4.5mM

**Table 4.** Results for the T-2000 Test

Item no.	Name	Age	Gender	First evaluation	Second evaluation
1	S.B.	15	M	24:04:00	23:21:00
2	V.T.	15	M	24:17:00	23:47:00
3	V.S.	16	M	24:13:00	23:41:00
4	I.C.	16	F	24:48:00	24:07:00
5	C.G.	12	F	24:57:00	24:01:00

From Table 2, we can observe an improvement of the results in the final assessment for all five subjects. They swam in the second evaluation an average of 40s faster than in the first one. The biggest progress was registered by the participant C.G., with 56 seconds. The smallest progress was registered by the participant V.T., with 30 seconds (Fig. 7).



**Fig. 7.** Graphical representation of the results from the T-2000 Test

#### 4. Discussions and conclusions

The division of physical effort carried out by pubertal swimmers during aquatic training on the model used for senior athletes offers the coaches an efficient way of enhancing the aerobic capacity.

Analysing the results obtained through the T-2000 test, we can conclude that the swimmers have improved their aerobic capacity, as indicated by a decrease in total swimming time with an average of 40s.

Thus, by rational and rhythmic use of training methods based on zoning efforts throughout the observation period, we achieved the improvement of the aerobic capacity in all of the subjects – *the research hypothesis is confirmed*.

Also, by using advanced methods of monitoring the effort made by pubertal swimmers during training, coaches can conduct workouts with greater accuracy in order to fulfil the training objectives. The methods we have used are easy to implement in training pubertal swimmers. This helps them keep their pleasure for long hours in the pool and their interest in competitive sports.

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